# *PALEOCHARIS NEARCTICA* GEN. AND SP. NOV (CYPERACEAE) IN CRETACEOUS CANADIAN AMBER

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## ABSTRACT

**Paleocharis nearctica** gen. & sp. nov. (Cyperaceae) is described from a Late Cretaceous achene preserved in Canadian amber. *Paleocharis* is characterized by a narrowly oblong, slightly falcate lenticular achene with a cuneate base and truncate apex, a weak constriction between the lanceolate - obclavate stylopodium that is only slightly set off from the achene, and numerous (over 200) smooth hair-like perianth bristles. The proximal half of each bristle is composed of thick-walled dark cells while the distal half is formed by thin-walled, light-colored cells.

KEY WORDS: Cretaceous amber, fossil sedge, Cyperaceae, Alberta, Canada

## RESUMEN

Se describe **Paleocharis nearctica** gen. & sp. nov. (Cyperaceae) a partir de un aquenio del Cretácico superior conservado en ámbar de Canadá. *Paleocharis* se caracteriza por un aquenio estrechamente oblongo, ligeramente falcado y lenticular con una base cuneada y ápice truncado, una débil constricción entre el estilopodio lanceolado - obclavado que apenas sobresale del aquenio, y las cerdas del perianto (más de 200) semejantes a pelos lisos. La mitad proximal de cada cerda se compone de células oscuras de paredes gruesas mientras que la mitad distal está formada por células claras de paredes finas.

## INTRODUCTION

Extant Cyperaceae are well represented in temperate, sub-arctic, and especially tropical regions worldwide from sea-level to over 5000 m, with genera concentrated in northern South America, southern Sudano-Zambesian Africa, and SW Australia (Goetghebeur 1998). Endemism in the family, at the generic level, is also concentrated in tropical America, tropical South Africa, and Australia (Goetghebeur 1998).

Cyperaceae are thought to have evolved during the Tertiary Period, with fossil records traced to the Paleocene (Raven & Axelrod 1974; Daghlian 1981; Smith et al. 2009), and are hypothesized have a West Gondwana origination (Bremer 2002). Here we describe a new fossil cyperaceous taxon preserved in Cretaceous Canadian amber. The amber piece containing the fossil originated from deposits of subbituminous coals and associated shales in Grassy Lake, Alberta, Canada. The amber-bearing sediments belong to the Late Cretaceous (Campanian) Foremost Formation (Judith River Group). These deposits were originally dated by Eberth and Hamilton (1993) at 79 million years and more recently by McKellar et al., (2008) at between 79.0 and 78.2 Ma.

## MATERIALS AND METHODS

The single specimen, which is essentially complete, was embedded in bioplastic for stabilization and mounted on a microscope slide (Fig. 1). While embedding specimens in bioplastic may stabilize the amber, it often restricts observations. Since the bioplastic covers all edges of the slide, the specimen could not be observed from the sides. Also, a milky deposit restricted examination of the opposite side of the specimen. Nevertheless, a clear unobstructed view of the dorsal surface of the specimen showed the important taxonomic characters. Observations and photographs were made with a Nikon stereoscopic microscope SMZ-10R and Nikon Optiphot microscope TM at magnifications up to 600×.

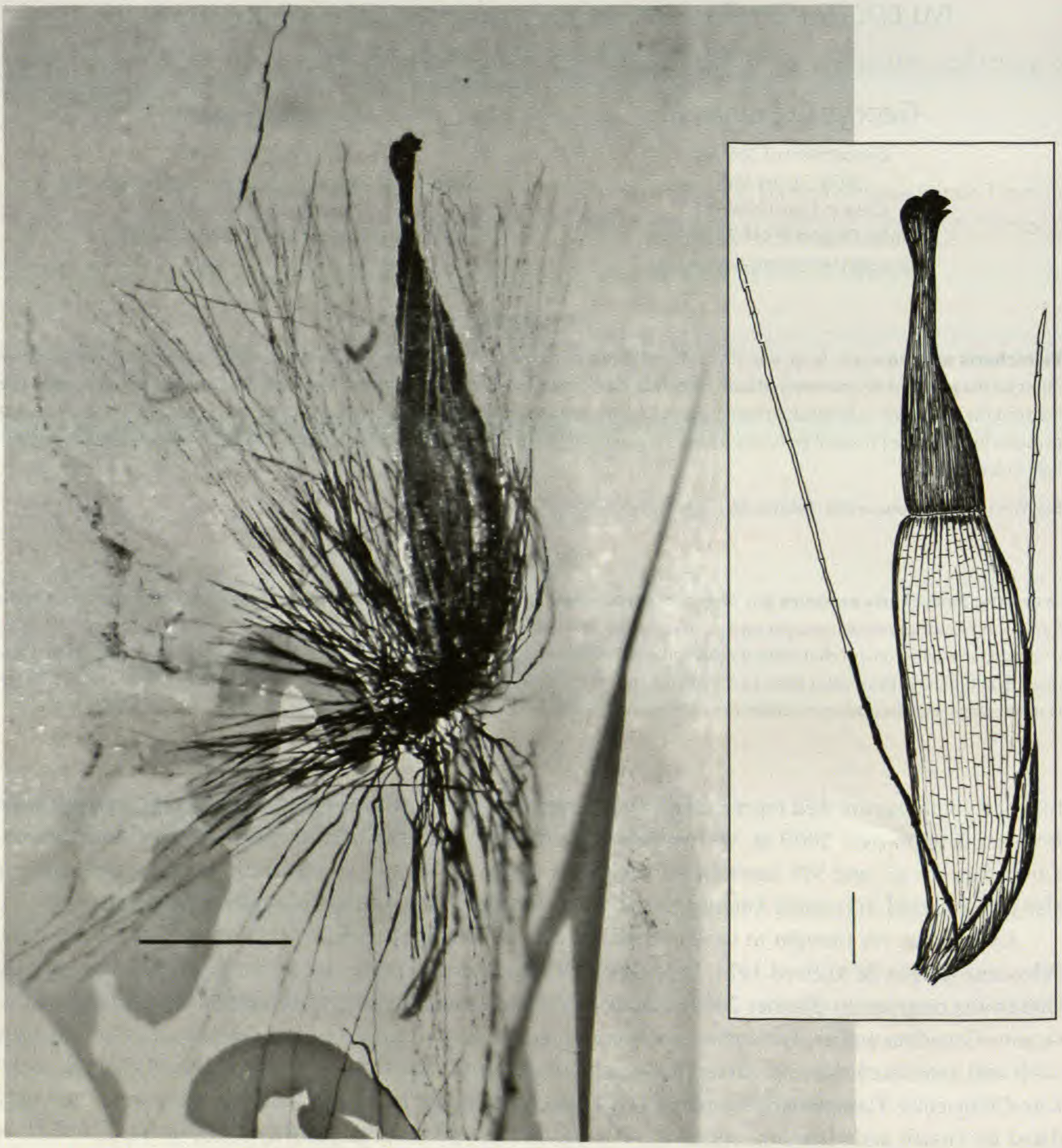

**Fig. 1. Holotype of *Paleocharis nearctica* gen. and sp. nov. in Cretaceous Canadian amber. Scale bar = 770 µm. Fig. 2 (inset). Drawing of *Paleocharis nearctica* gen. and sp. nov. in Cretaceous Canadian amber. Only two of the bristles are shown. Scale bar = 250 µm.**

## DESCRIPTION

The fossil is represented by a mature achene with an attached stylopodium (tubercle) and numerous hair-like perianth bristles. The specimen is complete, with only some of the bristles detached. Some minor compression and distortion occurred during the fossilization process.

**Paleocharis** Poinar & D.J. Rosen, gen. nov. Type: *Paleocharis nearctica* Poinar & D.J. Rosen, sp. nov.

***Generic diagnosis*: Achenes** with persistent style base (stylopodium), and numerous (over 200) smooth hair-like bristles equaling the length of the achene plus the stylopodium. The proximal half of each bristle is composed of thick-walled dark cells while the distal half is formed by thin-walled, light-colored cells.

**Paleocharis nearctica** Poinar & D.J. Rosen, sp. nov. (**Figs. 1–4**). TYPE: CANADA. ALBERTA: Grassy Lake amber deposits of subbituminous coals and associated shales, Foremost Formation, Late Cretaceous (middle Campanian), no date, *Ted Pike s.n.* (HOLOTYPE: Royal Tyrrell Museum in Drumheller, Alberta, Canada, accession number PMA 78.15).

***Specific diagnosis:*** **Flowers** with numerous (over 200) smooth, hair-like perianth bristles, 2.6–3.0 mm long, equaling the length of the achene plus the stylopodium (Figs. 1, 2); each bristle composed of a single row of 14–20 elongate cells; cells 0.1–0.26 mm long × 0.1–0.16 mm wide; proximal half of each bristle composed of thick-walled dark cells while distal half formed by thin-walled, light-colored cells (Fig. 3); stamens not seen; style with short lobes. **Achenes** narrowly oblong, lenticular, 1.7 mm long × 0.48 mm wide; surface with transversely oblong cells, smooth except for some delicate microscopic scales ranging from 0.58–0.7 mm in length (Fig. 4); dark brown; base cuneate, apex truncate with weak constriction (Fig. 2); **Stylopodium** lanceolate-obclavate, 1.2 mm long × 0.28 mm wide, dark brown (Fig. 2).

*Etymology.*—"Paleo" is from the Greek "palaios" for ancient and "charis" is Greek for beautiful. "nearctica" refers to the geographic location of the fossil.

## DISCUSSION

Consideration was given to the possibility that the achene could belong to other plant taxa. Members of the Asteraceae also have achenes as fruits, and a persistent calyx (pappus) comprising numerous capillary bristles in many species (Zomlefer 1994; Simpson 2006). However, the bristles are positioned apically usually crowning the achene rather than basally as in Cyperaceae (Zomlefer1994; Simpson 2006). Members of *Salix* L. and *Populus* L. of the Salicaceae have seeds with long, silky hairs, however these seeds do not contain tubercles or have pointed tips and the hairs on the seeds are flexible and single-celled, not stiff and multicelled. In addition some of the hairs on *Salix* and *Populus* seeds arise from the seed coat, whereas in the fossil, all of the bristles are hypogenous (Woody-Plant seed Manual 1948).

*Paleocharis* shows morphological resemblance to extant species in *Eleocharis* R. Br. and *Rhynchospora* Vahl in its achene bearing a swollen and persistent stylopodium, and to *Eriophorum* L. and *Scirpus* L. in its numerous elongate, smooth perianth bristles (Flora of North America Editorial Committee 2002). However, the narrow, elongate achene and stylopodium and numerous smooth, stiff, bi-colored bristles comprised of a single row of cells in *Paleocharis* are unique characters not known to occur in extant sedges. A comparison of the qualitative characters of the fossil fruit with those of the extant genera mentioned above is shown in Table 1. As *Paleocharis* overlaps in more achene morphological characters and dimensions with *Eleocharis* and *Rhynchospora*, we suggest its placement as an extinct member of Cyperoideae Suess (Simpson et al. 2007).

The darker, heavier cells forming the basal portion of the bristles may have insured that the achenes landed with the base making initial contact with the substrate and provided for the absorption of heat to bring about germination as suggested by Lye (2000) for some temperate species of Cyperaceae. The presence of numerous smooth perianth bristles suggests that *P. nearctica* achenes were wind-dispersed, similar to those of *Eriophorum*. In contrast, *Eleocharis* and *Rhynchospora*, both of which a predominance of species with variously barbed bristles, are known to be dispersed by animals, especially birds (Sauer 1988). While most dispersal is external on feathers, there are records of some *Eleocharis* seeds carried in the digestive system of birds (Sauer 1988).

Fossil sedge fruits are fairly common in Tertiary deposits (Collinson et al. 1993; Smith et al. 2009) but there are no accepted Mesozoic fossils. Putative Cyperaceae pollen was reported from Cretaceous deposits in New Zealand (Couper 1953), Berry (1911) described *Carex clarkii* as a putative leaf fossil from Late Cretaceous Coniacian deposits in New Jersey and *Caricopsis laxa* Samylina was described as a putative leaf fossil from the Early Cretaceous of Siberia (Samylina 1960). While Collinson et al. (1993) cite *C. laxa* as the earliest sedge fossil, they comment, "We know of no well-substantiated leaf fossils of the family" and others have regarded *C. laxa* as not being Cyperaceae (Daghlian 1981; Friis et al. 1987). Pollen from the Lattest Santonian to Maastrichtian strata in Western Canada described as *Penetetrapites inconspicuus* Sweet, was later considered as possibly belonging to the Cyperaceae (Sweet 1986; Braman & Koppelhuis 2005) but this has not been confirmed. More recently, Goetghebeur (1998) and Smith et al. (2009) reported that fossils of Cyperaceae are only known with certainty from the Paleocene.

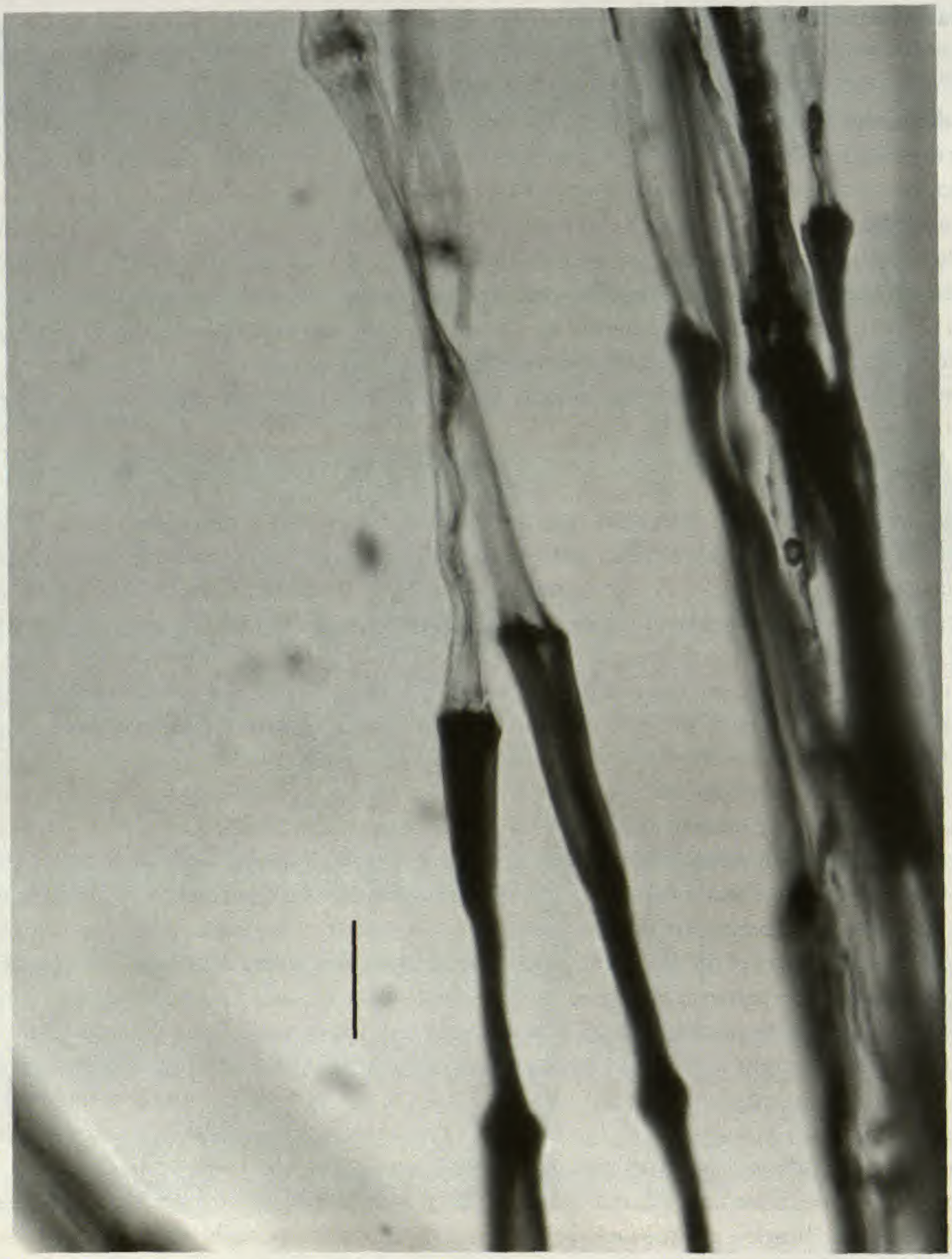

**Fig. 3. Transition zone separating lower dark, thick-walled and upper, light, thin-walled cells forming the bristles of *Paleocharis nearctica* gen. and sp. nov. in Cretaceous Canadian amber. Scale bar = 53 µm.**

The climate in Alberta during the Campanian Stage of the Late Cretaceous was subtropical to warm temperate. A large epicontinental sea divided North America and the resin-producing araucarians were not far from the Western bank of that sea (Braman & Koppelhuis 2005; Poinar & Poinar 2008; Smith et al. 1994). Based on chemical analysis, Canadian amber from Alberta was produced by araucarian trees, presumably belonging to the genus *Agathis*, commonly known as Kauri (Lambert et al. 1990). In the Waipoua araucarian forest of New Zealand, which is the only remaining virgin Kauri forest in the world, sedges, especially *Gahnia xanocarpa* (Hook.), are one of the dominant features of the undergrowth (Cockayne 1908; McGregor 1948). It is possible that *Paleocharis nearctica* was a common sedge in the undergrowth of the Canadian araucarian forest.

**Fig. 4. Two micro-scales on the surface of the achene of *Paleocharis nearctica* gen. and sp. nov. in Cretaceous Canadian amber. Scale bar = 26 µm.**

Table 1. Comparison of achene characters of *Paleocharis* with those of North American *Eleocharis*, *Rhynchospora* and *Eryophorum* (Flora of North America Editorial Committee 2002).

| Character | Paleocharis | Eleocharis | Rhynchospora | Eriophorum |
|---|---|---|---|---|
| style base | enlarged, persistent, different in appearance from the achene | enlarged, persistent, usually different in appearance from the achene | enlarged, persistent, usually different in appearance from the achene | deciduous or only a small portion persistent |
| bristle number | >200 | (0–)3–6(–10) or absent | 2–12(–20) or absent | (8–)10–114 |
| bristle type | straight, smooth, stiff | straight or curved, retrorsely (antrorsely) barbed or sometimes smooth | variously barbed or plumed, seldom smooth | straight, smooth, hairlike (rarely antrorsely barbed) |

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